Infrastructure Chapter Excerpt

Energy Infrastructure: Electricity

This section details existing infrastructure including generation, key trends, and challenges (including outages). Energy analyses and targets for the electricity, thermal, and transportation sectors, renewable energy generation siting, and recommendations can be found in the Energy Chapter.

Energy is a vital component of modern life. When sources of power are lost or interrupted, even temporarily, the rhythms of our lives are profoundly interrupted. Business and industry halt and residents and goods dependent on electricity and other types of power are at great risk. Our electric infrastructure in Vermont is increasingly vulnerable to extreme weather conditions due to climate change. This comes at a time when we anticipate significant increases in demand for reliable and affordable electricity due to overlapping causes including addressing rural infrastructure gaps, regional growth and development, increasing need for heating & cooling, as well as electrification of the thermal and transportation sectors.

While existing and potential sources of electric power in the region are more than adequate (see Enhanced Energy Element), the region's electric infrastructure is aging and reaching performance limits. While the costs of developing new infrastructure are high upfront, potential long-term cost savings are increasing as technology is rapidly advancing and markets are shifting to match need and the urgency of the climate crisis. Integrating renewable energy infrastructure more comprehensively into all scales of our planning across the region is important to not only maximize associated community benefits but also to minimize negative environmental and land use impacts of electric generation, transmission, and distribution (see Enhanced Energy Element). CVRPC's objective is to ensure that energy generation, distribution and transmission facilities are located, designed, and correctly-sized to support the Region's community and economic needs, which increasingly means it must be reliable, resilient, and affordable as well as sustainable to reduce operational costs and Green House Gas emission contributions (further reducing long-term costs).

Electric Distribution Utilities (DUs):

In 2021, Vermont distribution utilities purchased over 5.8 million MWh of electricity to meet the demand of their customers, of this 64% came from renewable resources and 18% came from carbon free resources. Also in 2021, Vermont distribution utilities retired just over 4 million renewable energy certificates[1] (i.e. equivalent to just over 4 million MWh of electricity) to meet their obligations under Vermont's Renewable Energy Standards, of this 72% of the electricity Vermont accounted for was renewable; including nuclear 90% of it was low-carbon[2].

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[1] Renewable energy credits (RECs) are the accounting system used to track all renewable electricity generation in or sold into ISO New England's regional electric system (ISO= Independent System Operator). These certificates ensure no two entities claim credit for that electricity, and provides a mechanism to buy and retire (aka take credit) for renewable energy generation regardless of their own production and use (or rather to compensate for it).

[2] See 3 one-page resources for more info: *Where does Vermont's electricity come from*, *Current policies & programs*, *and Tradeoffs between different sources of electricity*- these were made as part of the Say WATT? Regional Event Series in the fall of 2023 during which the Department of Public Service partnered with the RPCs to offer a series of engagement opportunities for Vermonters to weigh in on renewable electricity policies and programs: https://publicservice.vermont.gov/renewables

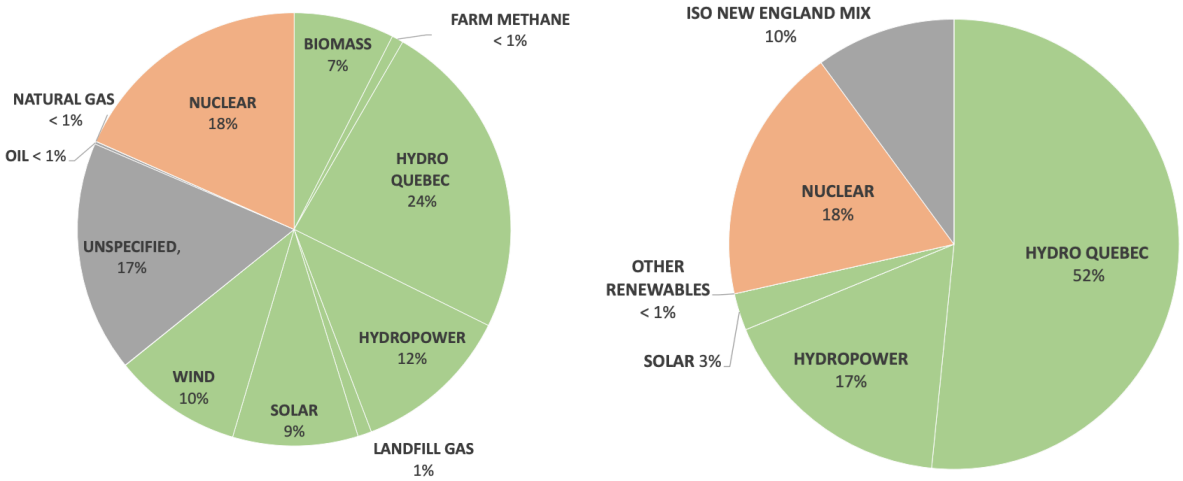

Figure 1: 2021 Vermont Electricity Characteristics: the left shows the electricity Vermont utilities generated and bought to meet demand, the right shows how renewable Vermont's electricity is considered based on renewable energy certificates (*Department of Public Service Webinar: Where Does VT Electricity Come From? https://publicservice.vermont.gov/sites/dps/files/documents/Webinar%201%20-%20Where%20does%20VT%20electricity%20come%20from.pdf*)

Central Vermont is served by four different distribution utility companies including Green Mountain Power, Washington Electric Cooperative, the Northfield Electric Department, and the Hardwick Electric Department (see Table 1, below, for customer counts and types by town; and Figure 2 for DU territory). Green Mountain Power (GMP) and Washington Electric Cooperative Inc. (WEC) are the region's primary distribution utilities, geographically covering most of the region. Central Vermont is unique in that most municipalities are served by at least two distribution utilities (exceptions are Warren, Waterbury, and Barre City served only by GMP; Northfield, Moretown, Berlin, and Calais are each served by 3 DUs). GMP territory is located primarily in the more populous valley areas such as Barre City, Montpelier, and many of the villages along the major transportation routes (Figure 2 above); WEC territory fills in the more rural, and primarily residential, areas. The Northfield Electric serves part of Northfield, as well as small parts of Moretown and Berlin; The Hardwick Electric Department serves much of Woodbury and a small sliver of Calais. Three phase power is limited in the region to where GMP provides it (see Figure 2 above), this is important for siting distributed generation projects but not absolutely required for most residential and even some smaller municipal/commercial plants.

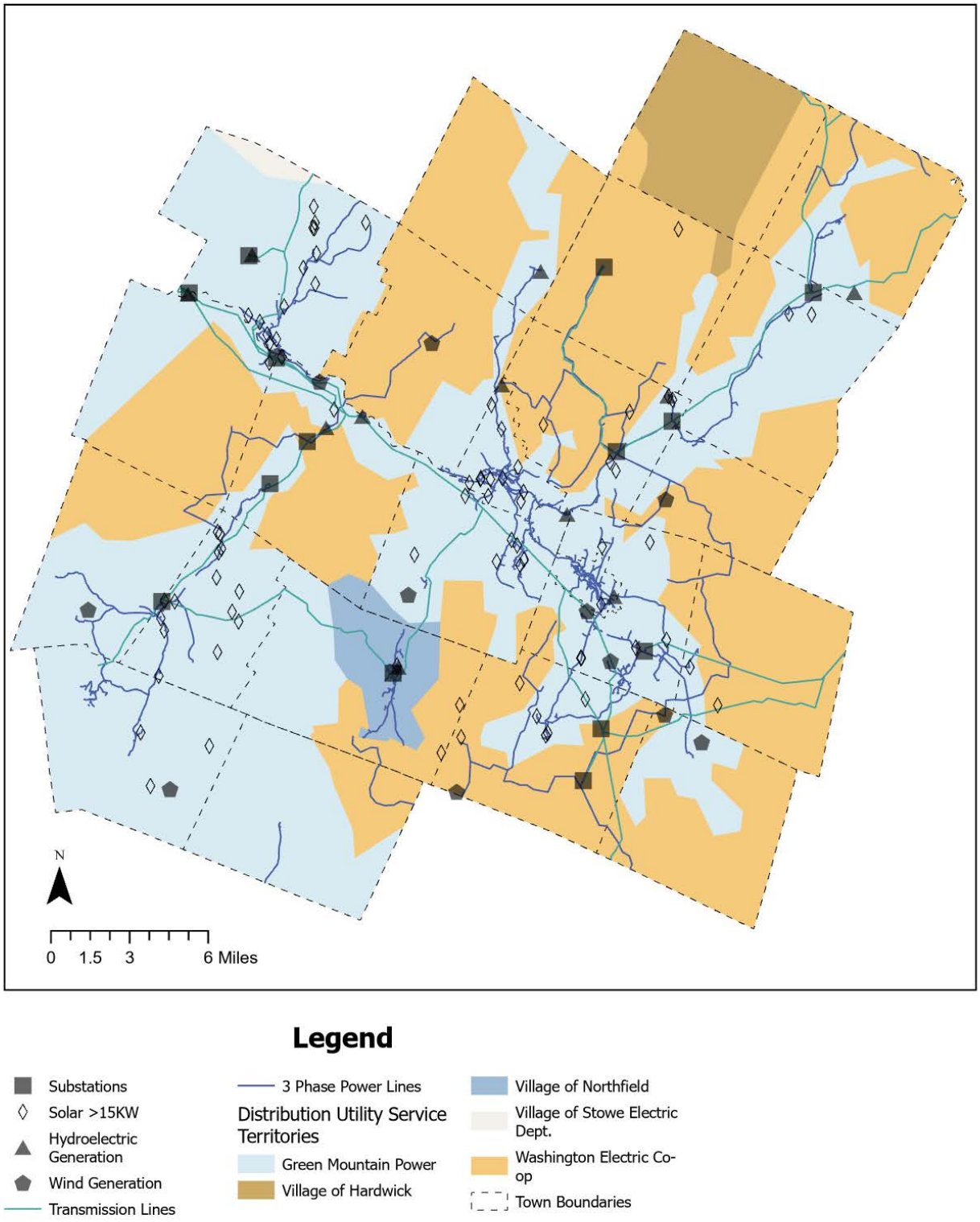

Figure 2: CVRPC Distribution Utility Territory and Infrastructure (substations, transmission lines, 3 phase power lines)
Place Holders: Distribution Utility Territory Map (only shows substations and transmission lines; distribution circuits GMP only available here)

Table 1: Customer/Member by Town and Distribution Utility (DU)

	GMP	WEC	Northfield	Hardwick

Regional Total	**27,246**	**7,167**	**2,200**	**738**[3]
Barre City	4,525			
Barre Town	3,745	412		
Berlin	1,398	83	*	
Cabot	297	508		
Calais	121	733		*
Duxbury	208	471		
East Montpelier	599	753		
Fayston	710	346		
Marshfield	547	202		
Middlesex	306	578		
Montpelier	4,794	18		
Moretown	585	325	*	
Northfield	271	289	2124[4]	
Orange	55	494		
Plainfield	406	355		
Roxbury	269	111		
Waitsfield	1,376	50		
Warren	2,494			
Washington	334	223		
Waterbury	3,072			
Williamstown	901	892		
Woodbury		78		
Worcester	233	246		

Table 2: Customer/Member by Type and Distribution Utility (DU)

DU	Dairy Farm	Residential	Commercial	Large Power	**Total**
GMP		22,337	4,909		**27,246**
WEC	33	6,725	398	11	**7,167**
Northfield					**2,200**
Hardwick					**738**

The Washington Electric Cooperative Inc. (WEC), a member-owner utility run by a 9-person member elected board, provides electricity to the more rural areas throughout Central Vermont. Its service territory covers a larger area geographically in Central Vermont than any other utility, serving approximately 7,167 customers. **Due to the rural nature of WEC's service area, residential users account for an unusually high proportion of total demand; furthermore, the rural infrastructure is not co-located as often with roads nor hardened (buried), making it both more susceptible to Vermont's increasingly frequent extreme weather and more difficult to maintain and repair.**

Central Vermont has 32 substations in 14 of our towns; most towns are at least partially served by additional substations outside the region. Distribution substation location, condition, and headroom capacity are important to

[3] Northfield Electric and Hardwick Electric did not provide updated customer counts by towns, these numbers come from their Integrated Resource Plans and the number from Hardwick Electric specifically reflects the number of customers on the Woodbury Circuit which may or may not reflect the true total customers in the region (a map of their circuits is not available online). Data requests were sent over the course of Fall 2023 and Winter 2024.

[4] Northfield has not provided specific customer counts by town; 2200 customers are served according to the Integrated Resource Plan; Efficiency VT data reported 2,124 residential premises served in Northfield, subtracting those reported by GMP and WEC gives this number although it should be noted that Efficiency Vermont data is simply given as residential premises not customers.

consider when proposing distributed generation (DG) projects (see Enhanced Energy Element for a description of barriers and costs). Ultimately, the different distribution utilities in our region have unique challenges and benefits, most towns can utilize coverage by 2 or more DUs to maximize opportunities and minimize limitations, however at the individual scale this is rarely possible. **The municipality can thus play a critical role in supporting residents and businesses to access key energy opportunities including renewable generation and storage, EVSE, energy efficiency measures, and more (see enhanced energy element).**

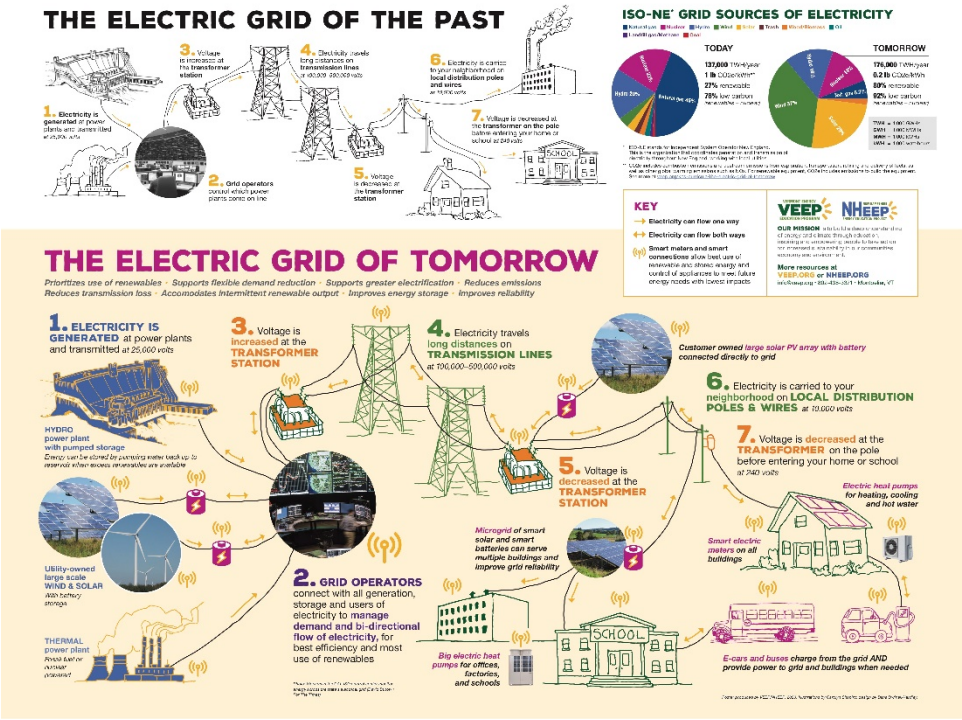

Figure 3: Electrical Grid Systems Primer, Poster from Vermont Energy Education Program[5]

Electric Transmission

The Vermont Electric Power Company, Inc. (VELCO) manages the safe, reliable, cost-effective transmission of electric power throughout Vermont and as part of the integrated New England regional network. VELCO updates its Long Range Transmission Plan every 3 years. The 2021 Long Range Transmission Plan[6] highlights that peak demand is forecast to grow due to accelerating electrification of the heating and transportation sectors. While the transmission system has sufficient capacity to serve expected future demand for the first 10-years of the 20-year planning horizon:

- Load management is necessary to serve high electrification loads consistent with Vermont's total energy goals in the 20-year planning horizon,
- Currently, DG projects are reviewed on a project-by -project basis without regard to transmission system impact, to prevent further stressing transmission and distribution systems careful coordinated statewide planning is required to successfully integrate future distributed generation and storage without significant grid reinforcements;
- There are sub-transmission scale reliability issues (categorized as causing high or low voltage, or a thermal overload in which equipment exceeds its rate temperature).

As DUs take on more and more interconnection of distributed energy projects, coordination between VELCO, DUs, the region[7], and municipalities will be increasingly important to ensure not only Vermont and its stakeholders can meet their respective goals, but that we do so in a manner that minimizes negative impacts to our landscapes and

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[5] Vermont Energy Education Program provides resources and curricula including additional posters on Energy Audits and Actions, Heating Vermont Homes, Vermont's Climate Action Plan, VT Electricity Use and Sources, the Climate Impact of Getting to School and more (https://veep.org).

[6] https://www.velco.com/assets/documents/2021%20VLRTP%20to%20PUC_FINAL.pdf

[7] noted also by the Department of Public Service in the 2022 Vermont Comprehensive Energy Plan (e.g. pages 68, 87) https://publicservice.vermont.gov/sites/dps/files/documents/2022VermontComprehensiveEnergyPlan_0.pdf

natural resources and maximizes benefits to all Vermonters foremost those who have been disproportionately burdened by energy costs and reliability issues to build resilience for all. CVRPC continues to work with DUs to integrate their Integrated Resource Planning into regional and municipal planning and project development and to advocate that regional and municipal energy planning and goals in turn are considered in their Integrated Resource Planning Processes.

Efficiency Utility

Efficiency Vermont is the statewide energy efficiency utility; it provides technical advice and financial incentives to residents, businesses, non-profits, and municipalities alike to reduce their energy use and costs with efficiency buildings, equipment, and lighting. CVRPC works closely with Efficiency Vermont to connect municipalities with opportunities and to provide support to energy committees and coordinators with resources for their communities. CVRPC also works with Efficiency Vermont to provide data on consumption and efficiency measures implemented, as well as to adapt incentives programs and support in recovery situations (e.g. July 2023 floods). More information about energy efficiency and conservation, as well as supporting partners can be found in the Enhanced Energy Element of this plan. Additional key partners include Capstone Community Action who provide income-based fuel support, weatherization, and more to community members with the lowest incomes and highest needs.

Existing Generation & Storage Facilities

For an in-depth discussion of future renewable generation in the context of demand and energy planning see the Enhanced Energy Element, this section summarizes existing energy infrastructure including non-combustion-based renewables (solar, wind, and hydroelectric), combustion-based renewables (biomass specifically for electricity generation- for discussion on biomass and the thermal sector see the Energy chapter), nuclear energy, and fossil fuels (as categorized by the 2022 State Comprehensive Energy Plan).

There is one remaining fossil fuel peaking power plant in Central Vermont in Berlin run by Green Mountain Power:

Table 3: Regional Fossil Fuel Generation

Resource Type	MW	Town	Name	Details
Fossil Fuels	46.5MW	Berlin	Berlin 1	Gas Turbine, 46yo. Largest peaking plant in VT consisting of a gas turbine generator and 2 engines run on low-sulfur kerosene fuels. Full winter output is 50MW; 40MW in summer. Improvements were made in 2008, 2012, 2013, 2019, and 2020[8].

Existing Renewable Energy Generation has noticeably increased since the last plan:

Table 4: Existing Renewable Electricity Generation

Existing Generation	April 2024		2016	
Resource Type	MW	MWh	MW	MWh
Solar	47.17	60943.74	24	29,919
Wind	0.24	465	0.14	486
Hydroelectric	26	134,861.4*	25	88,467
Biomass (wood, methane, farm biogas)	0	0	3	13,091
Total Existing Regional Renewable Electricity Generation	**73.42**	**196,270.16**	52.14	131,963
Total Storage	**8.18MW****			

Sources: Distributed Generation Survey (Distribution Utilities, Public Utilities Commission, Department of Public Service), Distribution Utilities Integrated Resource Plans, Federal Energy Regulatory Commission, Low Impact Hydropower Institute (Hydroelectric), Town Plans, State Comprehensive Energy Plan.

**calculated using constants provided in the supplement (consistent with those used by the Public Service Department and the Generations Scenarios Tool), except for hydroelectric which was taken directly from DUs IRPs, FERC, and LIHI.*

[8] page 192 of Green Mountain Power's 2021 Integrated Resource Plan https://greenmountainpower.com/wp-content/uploads/2021/12/2021-Integrated-Resource-Plan.pdf

The closure of the Moretown Landfill is a significant change for Central Vermont; while there are thus no longer biomass electricity generation facilities in the region, WEC acquired a significant portion of their power to serve their territories including Central Vermont from the Coventry Landfill facility among others biomass facilities just outside the region. CVRPC does not anticipate biomass becoming an electricity generation source in the region, although it plays a critical role in the thermal sector for both space and water heating and will continue to be a key resource for residential heating in particular (see Enhanced Energy Element).

The region's hydroelectric facilities, though few in number make up over a third of the region's renewable generation, balancing ecological considerations, flood management, and energy generation potential at these and potential future sites is a high priority topic for future planning efforts (see Map of existing and potential hydroelectric sites in the Enhanced Energy Element). These are not new resources, despite the contrast in the table above, they were not reported in the previous plans assessment which likely was sourced specifically from the distributed generation inventory (DG Survey, see below) based off the Public Utilities Commission which focuses, generally, on smaller projects most participating in the State's net-metering program.

By and large the most change has been solar generation; in terms of numbers most are small residential scale plants (many, but certainly not all, are rooftop- we do not have data specifying the type. Below, in the table of renewable distributed generation in our region (<5MW), there is a clear preference, or at least ability to access and implement, smaller scale projects.

Table 5 Distributed Generation Projects <5MW (DG Inventory as of 2/2024)

Total from DG Survey (not regional total)	MW	# Projects	
Generation <15kW Category I	14.69856	2233	Residential scale- most solar.
Generation 15kW to <150kW (Category II)	6.56739	184	Generally includes Municipal/Community Scale (not limited to)
Generation 150kW to <500kW (Category III)	6.18665	23	Currently have to be preferred sites to participate in net metering
Generation 500kW+	22.944	23	
DG Total:	50.3966	2463	

Source: Public Service Department 2/1/24, Current DG Survey (<5MW), see Methodology for aggregation below

This is very much in line with the results of community engagement efforts CVRPC conducted in the fall of 2023 in partnership with the Department of Public Service and the other RPCs. CVRPC found that in addition to consistent support for a diversity of renewable resources, that support was bounded by scale- as in support decreased with the scale of the project increasing (see full report[9]). C**VRPC has found both in these engagement opportunities and while working with municipalities more broadly, technology type is not generally the key factor except for strongest opposition. Instead scale, location, and perceived community benefits/burdens are important to the region. An emphasis on local, community-scale, generation and storage is paired with other measures including efficiency/weatherization, waste heat recovery opportunities, dual land use, energy independence, and more representing a more holistic view of energy systems that stemmed from a wider variety of perspectives than are often considered. See the Enhanced Energy Element for considerations and discussion of future renewable energy generation and more.**

Inset box on Current State Renewable Electricity Policies/Programs

Key Challenge

Vermont Distribution Utilities, to varying degrees, are implementing programs to smooth energy demand peaks and valleys through flexible load management, incentives, and battery storage. These initiatives are intended to increase system reliability, help address the climate crisis, and lower customer costs. The 2021 Vermont Long-Range

[9] CVRPC Report on Renewable Energy Standards Update Regional Engagement Events https://publicservice.vermont.gov/sites/dps/files/documents/CVRPC%20RES%20Event%20Summary.pdf

Transmission Plan continues to emphasize the importance of thoughtful siting of generation with respect to interconnection and grid capacity, grid automation, deployment of battery storage and flexible load management programs, grid reinforcements, as well as the communications infrastructure necessary to synchronize energy demands with supply across DUs, to ensure Vermont's transmission grid reliably serves expected load growth. **The implications for our regional infrastructure, to the municipal, and household scales, include the importance of the "get ready" approach to retrofitting/switching over individual systems and components to be in line with, and thus benefitting from these broader investments which includes at times, higher up front costs and/or more intentional and longer-term phased planning- the Enhanced Energy Element will touch on many specific measures further.** CVRPC thus anticipates, the key challenge facing our region is the capacity and coordination to draw down unprecedented funding and invest in not only transforming the energy sectors to meet legally binding GWSA goals to mitigate future climate change, but to support all our communities down to the local scale so that none are left behind or without options.

The vulnerability of our critical infrastructure including our energy systems to high wind, wet heavy snow, and flooding has become increasingly apparent (see Climate Chapter). In the last 5 years or so, CVRPC has noticed the increased consideration of climate impacts in DU planning, for example GMP has conducted topographical surveys of their substations to assess their location in relation to FEMA-designated floodplains.[10] While the Middlesex transmission station and hydro generation are both located on ground higher than the 100-year and 500-year floodplain, the Waterbury distribution substation was rebuilt outside the 100-year flood plain (moved from 48 Winooski Street, Waterbury to Cloverdale Lane), and the Barre South End distribution substation was raised three feet at its current location (121 South Main Street Barre City) so that it is above the 100-year floodplain (Riverton in Berlin remains in the 500-year floodplain). **Again, due to structure, dominant customer type and distribution, not to mention historical development, our region's DUs are not equipped equally to handle large infrastructure projects nor the increasingly demanding recovery efforts in response to extreme weather (see outages table)**. CVRPC will continue to work with regional and state stakeholders, including the DUs themselves, to **identify opportunities for funding and technical assistance**, **build transparency in planning processes, and promote public data sharing to support municipal and community efforts including Local Hazard Mitigation and Local Emergency Management Planning, as well as the development of projects and programs that promote on-site back-up power and/or the establishment of community micro-grids.**

[10] 2021 GMP IRP Appendix I: Substations https://greenmountainpower.com/wp-content/uploads/2022/01/Appendix-I-Substations.pdf;